

**U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

FAA LOGISTICS CENTER SPECIFICATION

200 and 300 watt PAR-64 VASI Lamps



This Specification contains 41 pages

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1	FAA Specification FAA-E-2351a	I-V

1.0 SCOPE

1.1 Scope

This specification defines the requirements for PAR-64 tungsten-halogen lamps used in a variety of Visual Approach Slope Indicator (VASI) systems. VASI systems provide the pilot with a visual confirmation of the correct angle for landing the aircraft.

Figure 1 illustrates the view from the pilot's seat.

1.2 Classification

This specification defines the following lamps.

Type I lamp, PAR-64, Mogul End Prong Base:

Ordering designation: Q6.6APAR64/2P, 200 watt nominal rating.

Ordering designation: Q6.6APAR64/3P, 300 watt nominal rating.

2. APPLICABLE DOCUMENTS

2.1 FAA Documents

The following FAA documents form a part of this specification.

2.1.1 FAA Drawings

- D-5556-7 VISUAL APPROACH SLOPE INDICATOR PAR 64 LAMP AND MOUNTING FRAME DETAILS
- D-5556-15 VISUAL APPROACH SLOPE INDICATOR MODIFIED PAR 64 LAMP AND MOUNTING FRAME DETAILS
- D-5556-16 VISUAL APPROACH SLOPE INDICATOR BULKHEADS, LENS AND LAMP MOUNTING DETAILS
- C-5407-9 LAMP, PAR-64 BULB, MOGUL END PRONG, OUTLINE DIMENSIONS
- C-5407-10 VASI LAMP TEST SIMULATOR
- C-5556-4 VISUAL APPROACH SLOPE INDICATOR FILTER – LENS ASSEMBLY
- DE-C-3390A Lamp Life Definition

2.2 Military Documents

The following military and federal documents form a part of this specification and are applicable to the extent specified herein.

2.2.1 Military Standards and Specifications

MIL-STD-129L	Marking for Shipment and Storage
MIL-STD-810F	Test Method Standard for Environmental Engineering Considerations and Laboratory Tests
MIL-C-25050	COLOR, AERONAUTICAL LIGHTS AND LIGHTING EQUIPMENT, GENERAL REQUIREMENTS FOR

2.3 Other Standard Documents

The following national standards form a part of this specification and are applicable to the extent specified herein.

ANSI/ASQC Z1.4	Sampling Procedure for Inspection by Attributes
ASTM D 3580	Standard Test Method of Vibration (Vertical Sinusoidal Motion) Test of Products
ASTM D 3951	Standard Practice for Commercial Packaging
ASTM D 4169	Standard Practice for Testing of Shipping Containers and Systems
ASTM D 5112	Standard Test Method for Vibration (Horizontal Linear Sinusoidal Motion) Test of Products

2.4 Document Availability

Copies of this specification, other applicable FAA specifications and FAA drawings may be obtained from the Contracting Officer in the office issuing the Screening Information Request (SIR).

Copies of ASTM documents can be obtained from:

ASTM

100 Barr Harbor Dr.

West Conshohocken, PA 19428

Telephone (610)-832-9500

Or electronically at www.astm.org

Copies of ANSI/ASQC documents may be obtained electronically from <http://e-standards.asq.org/e-books/> or from resellers of ANSI standards

Copies of MIL-STD-129L, MIL-STD-810, and MIL-C-25050 can be obtained from:
DODSSP
Customer Service
Standardization Documents Order Desk
700 Robbins Avenue, building 4D
Philadelphia, PA 19111-5094

Military documents may also be obtained using the ASSIST option at the DODSSP Internet site: www.dodssp.daps.mil/dodssp.htm

2.5 Precedence

In case of conflict between this specification and the specifications and standards referenced in 2.1, 2.2 and 2.3, this specification shall govern. The contractor shall notify the Contracting Officer in writing, of any conflicts discovered and not resolved by this order of precedence.

3. REQUIREMENTS

3.1 General

The lamps of this specification are used for outdoor operation. All lamps shall be sealed in a PAR-64 envelope, consisting of internally coated reflector and a lens or cover glass.

Type I lamps, mounted in a variety of FAA VASI lamp boxes, are installed adjacent to runways beginning a maximum of eight hundred feet inward from the landing threshold. The lamp box nearest the edge of the runway is a minimum of 50 feet (fifty feet) from the runway edge.

The lamps shall function in VASI boxes in continuous or intermittent outdoor service under the environmental conditions specified herein

3.2 Requirements for all specified lamps

3.2.1 Fungus Proof Materials

Whenever practicable, materials that are nutrients for fungi shall not be used. When such materials must be used and are not hermetically sealed, they shall be treated with a fungicide agent. The fungicide shall be approved as safe for human contact if applied to the exterior of the lamp.

3.2.2 Metals

Metals shall be inherently corrosion resistant.

3.2.3 Mogul End Prong

Mogul end prongs of Type I lamps shall conform to the physical dimensions shown in FAA drawing C-5407-9. A minimum 0.465 inches long, flat, prong surface shall be provided for attachment of a lamp connector.

3.2.4 Marking

All lamps shall be permanently marked on the back of the reflector body with the ordering designation, rated wattage, rated current, day, month and year of manufacture and the manufacturer's name, logo or trademark or CAGE code. The marking shall be permanent and remain legible up to the minus three sigma (-3σ) hours of rated life of the specific lamp design submitted for qualification.

The manufacturer's name, logo or trademark molded into the lens or body of the lamp may be substituted for that portion only of the requirements of the preceding paragraph.

3.2.5 Workmanship

All lamps shall be free from blemishes and defects. Marking shall be clear, legible, and durable. Soldering, welding, brazing, cementing, and wiring shall be thorough. Alignment of parts shall be accurate. The mogul end prongs shall be straight, flat, without bends, twists or burrs. The sealed lamp shall be free of loose internal items and debris.

3.2.6 Cleaning

All lamps shall be thoroughly cleaned, and all loose, spattered, or excess solder, metal chips, flux, and other foreign material shall be removed during and after final assembly.

3.2.7 Packing, Packaging and Marking

All lamps shall be packed, packaged and marked for storage and reshipment in accordance with Section 5.

3.3 Reserved

3.4 Lamp Performance Requirements

3.4.1 Wattage Rating

The nominal wattage ratings are the maximum rated current wattage ratings for the specific lamp. All references to rated power are referring to the maximum current rating

of the specific lamp. Wattage shall be measured over a one minute time period and is the average power measured in this one minute. The measurement shall be taken after the lamp has been conditioned or burned in for a period of time equal to one percent (1%) of the rated life of the submitted lamp design. No individual lamp shall have less than ninety two percent (92%) or exceed one hundred and five percent (105%) of the average measured wattage rating of the design qualification sample.

The following formula will be used to adjust the offered price for all qualified lamp designs: Wattage, average value for the offered design sample as established by the qualification testing, times the hours of operation yielding the least cost of ownership by the FAA for the design, times \$0.048 per kilowatt hour.

All offered prices will be adjusted using the nominal wattage of the ordering designation as the baseline. More energy efficient designs will have their offered price adjusted downward. Refer to section 3.4.5, Life and 4.3.2, Qualification Testing.

3.4.2 Candela

The minimum acceptable candela values and the distribution of candela in the beam of each specific ordering designation lamp are specified in Table I. All luminous quantities specified or required by this specification are the sum of the visible radiant energy from a wavelength of three hundred-eighty nanometers (380nm) to seven hundred-seventy nanometers (770nm) inclusive.

All offers shall include as part of the offer the beam and field candela distributions in isocandela diagram format, and the total lumen output of the offered lamp design.

3.4.3 Short Term Overload

Lamps shall be capable of operating at one hundred ten percent (110%) of maximum rated current for a period of two (2) minutes, once per hour (two (2) of every sixty (60) minutes) with no failure

3.4.4 Operating Power Range

All lamps specified by this specification are operated over a wide range of alternating current (AC) input to adjust their intensity to atmospheric conditions at the time. All references to current rating or input in this document are to root mean square (rms) AC current. All lamps specified herein shall operate as a halogen cycle lamp over the entire range of input power specified.

Six point six (6.6) ampere lamps shall operate at any input current from a minimum of two point eight (2.8) amperes to the maximum rated current of six point six (6.6) amperes.

3.4.4.1 Candela Output over Operating Power Range

The candela output of all designs will be established by photometric testing. This information establishes the visible light available to the customer and is useful in establishing or adjusting power input levels within the operating range.

3.4.4.2 Operating Power Characteristics

The FAA systems, in which all lamps defined by this specification are operated, power each lamp with an alternating current (AC) waveform of voltage that contains a high number and significant amount of harmonics of the nominal sixty-hertz (60Hz) input frequency. The exact harmonic content varies by system. All systems produce a distribution of harmonics described by the Fourier equations. The dominant harmonics are the odd, i.e. 3rd, 5th, and 7th, up to the 31st. Selected systems contain even number harmonics when operated at lower power steps.

Lamps defined by this specification shall meet all other specified requirements when operated continuously at any input current with an imposed peak voltage of one hundred fifty percent (150%) of the peak voltage that would be imposed by an undistorted sixty- hertz (60Hz) voltage waveform.

An example: *A nominal three hundred (300) watt, six point six (6.6) ampere lamp would have a nominal steady state impedance of 6.89 ohms at nominal full power.*

The root mean square (rms) voltage imposed on the lamp filament would be 45.45 volts. The peak voltage imposed on the lamp filament by an undistorted voltage waveform would be 64.29 volts. The distorted voltage waveform supplied by FAA VASI systems can have a peak voltage of 94 volts with an rms voltage of 45 volts.

Figures 2, 3, 4, 5, 6 and 7 are the power characteristics of the type FA-10042 VASI system. These measurements were made in controlled conditions with the input power to the system stable.

Lamps defined by this specification shall be capable of withstanding without damage, or loss of rated life, an applied voltage equal to 125% of the filament voltage at maximum rated current.

3.4.5 Life

The life of current regulated lamps to be provided in accordance with this specification is defined by FAA drawing DE-C-3390A.

The terms; rated life, average life, rated average life, and average rated life, shall all be considered as defining the same period of time. Lamps defined by this specification shall have a rated life of two thousand (2,000) hours. Offers with greater, or lesser, rated life will also be considered.

All lamp design offers shall include the standard deviation (sigma)(σ) of lamp life hours and rated life hours for the specific lamp design offered.

The basic equation for the cost of ownership of lamps is:

$$\text{\$} = N(.xxx)(\text{\$}L + \text{SL}\text{\$}) + N(\text{\$}L + \text{GL}\text{\$})$$

- N equals the number of lamps in the specific system.
.xxx equals the decimal equivalent of sigma, or the decimal of the percentage of lamps expected to fail at the point in time.
\$L equals the cost of the lamp.
SL\$ equals the cost of spot replacement for a single lamp.
GL\$ equals the cost per lamp for group re-lamping the entire system.

The cost of ownership of each offered design will be calculated at one tenth (0.1) sigma increments from the minus three sigma (-3σ) value to the rated life for the specific design using the offered lamp price, and lamp numbers and re-lamping costs appropriate to the system(s) that use the ordering designation(s) identified in the solicitation.

3.4.6 Candela Maintenance

The lamp beam candela output after the hours of full power operation required to attain the minus three sigma (-3σ) life of the submitted lamp design shall be no less than ninety five percent (95%) of the initial beam candela output.

3.4.7 Lamp Dimensions

As shown on FAA drawing C-5407-9.

3.4.8 Environmental Requirements

3.4.8.1 General

Lamps shall operate as a halogen cycle lamp, in FAA VASI boxes, in the range of environmental conditions specified.

3.4.8.2 Temperature

Type I lamps, any ambient air temperature between -60°F (-51°C) and $+120^{\circ}\text{F}$ ($+49^{\circ}\text{C}$).

3.4.8.3 Altitude

Type I lamps, any altitude from sea level to 10,000 feet (3,048 meters) above sea level

3.4.8.4 Humidity

Type I lamps, any relative humidity between zero and one hundred percent (0% to 100%) over the ambient air temperature range specified.

3.4.8.5 Vibration

Type I lamp design shall be one for rough service. The diversity of FAA VASI boxes and foundations is such that specific frequencies and amplitudes cannot be defined. Structures usually resonate at relatively low frequencies.

Each and every specific lamp design for Type I lamps shall include those specific frequencies which will result in the lamp filament and/or filament capsule in harmonic resonance. The range of frequency data required is from one (1) to two hundred (200) hertz. No harmonic resonance in this frequency range of one to one hundred Hertz (1 to 100Hz) is the required result.

Harmonic resonance, as used herein, means these parts exhibit an increase in physical movement at a specific frequency, analogous to a vehicle (filament) vibrating from an out of balance tire (propeller harmonic).

MIL-STD-810F Method 514.5, VIBRATION, Procedure I and Method 516.5, SHOCK, Procedure I, provide rationale and guidance for the necessary three (3) axis testing. Additional guidance may be found in ASTM D 3580 and ASTM D 5112.

3.5 Historical Information

The earliest VASI systems used tapped transformers and series resistors to adjust the individual lamp current settings. The first system used a lamp identified only as a 200 watt, Prefocused, General Electric product, Q6.6A/PAR64/2P.

Subsequent systems referenced this lamp, or identified the lamp as GFE (Government Furnished Equipment), or referenced specification FAA-E-2351. A copy of FAA-E-2351a is attached as Appendix 1, as a reference only.

The first VASI system using static switched power supply to provide lamp power was acquired on contract DOT-FA75WA-3694. All systems acquired since have used static switching to provide and regulate lamp power.

This information is provided solely to inform prospective offerers the origin and known history of the design parameters of the original lamp. Appendix 1 provides no definition of the requirements of this specification.

3.6 Optional Designs

The basic criteria for optional designs are:

Function: Current input and light output match the requirements of this specification.

Fit: Fit in the existing systems.

Form: Recognizable as a light source.

Figures 8 and 9 are included to illustrate with pictures the general arrangement in light housing assemblies (LHA's). These photographs are of the oldest VASI system. The large resistors are not used in systems acquired since the mid 1970's.

There may be optional designs using cartridge or tubular lamps, reflective coatings, another focusing reflector, longer filaments and the like, which could improve the life of the lamp or the uniformity of the light output pattern or reduce the lamp wattage.

Optional designs will be considered and may be approved by the procuring authority.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality Control by Contractor

As a minimum, the manufacturer of lamps furnished in accordance with this specification shall have and maintain a quality control program in accordance with ISO 10005, Quality management - Guidelines for quality plans.

ISO 9001 or ISO 9002 registration of the lamp manufacturer will be accepted as verification of the required quality control program. The FAA may audit the manufacturers quality control program at its sole discretion. All contractors shall provide either proof of the manufacturer's ISO registration or a copy of the manufacturer's quality control plan.

4.2 Government Inspection

The term "government inspection" used in this specification includes, but is not limited to: Inspection for the government by a qualified laboratory, FAA witnessing contractor's testing, FAA testing, and FAA inspection, as deemed necessary to verify compliance with the requirements of this specification and all requirements of the contract.

The words "defect" and "nonconformance" shall be used interchangeably, as are "rejected" and "nonconforming". Critical items are those that are cause for rejection.

Major items are those which may be corrected by the contractor and, in general; do not usually affect the life or performance of the lamp.

4.2.1 Critical Defects or Nonconformances

Any cracking, separation, or fracture of the lens, cover, body or assembly of the lamp. Failure to operate as a lamp. Failure to deliver and maintain the minimum specified light output and distribution of light output. Separation of the reflector from the body. Failure to meet the rated life of the specific lamp design. Any failure to meet specified

performances of the qualification tests for the lamp type. Lamp size or shape not as specified.

4.2.2 Major Defects or Nonconformances

Packaging, packing, dirty lamp interior, markings not permanent, terminals bent, curved or corroded.

4.3 Qualification Testing

Qualification testing is the process of verifying offered lamp designs can meet the requirements of this specification. The requirements of this specification are the minimum requirements for qualification of each specific lamp design. Offered lamp designs which pass qualification testing will be designated a qualified product. The rated life and wattage of the lamp design shall apply to all lamps furnished the FAA thereafter.

The critical and major defects listed in 4.2.1 and 4.2.2 apply to all qualification tests in addition to the specific requirements of the test(s). Sequential numbers shall individually identify all lamps in each submitted qualification sample. These lamp numbers shall be referenced for the duration of testing.

The hours of maximum rated current operation of each lamp shall be recorded for each specific test requiring maximum rated current operation. These recorded hours shall be included in the total hours of maximum rated current operation for the Life and Candela Maintenance Test, reference 4.2.5.6.

A qualified independent testing laboratory employed by the FAA will perform qualification testing. The contractor shall submit twenty two (22) samples of each offered Type I lamp design for qualification tests.

The qualification samples will be returned to the offering contractor at the completion of testing with a copy of the test results for the contractor's qualification sample.

4.3.1 Qualification Testing of Type I Lamps

Twenty (20) of the twenty two (22) submitted design qualification sample lamps will be randomly selected for the specific tests required by Table II. All twenty (20) lamps shall pass these six (6) tests to become a qualified product.

The remaining submitted sample lamps will be used as replacements for any lamps accidentally damaged or destroyed during testing. If the testing laboratory damages or destroys more than two (2) submitted sample lamps from any lot of twenty-two (22) the contracting officer may allow the submitting contractor to furnish replacements.

4.3.2 Qualified Lamps

Qualified lamp designs shall remain qualified unless disqualified as a result of the inspection and testing of section 4.4 or the defining FAA specification is changed. The FAA may elect to re-qualify all lamps of any or all-ordering designations in the future.

4.4 Acceptance Testing

Acceptance testing is the process of verifying qualified lamps supplied to the FAA are being manufactured to meet the lamp design performance capability verified by qualification testing. Acceptance of all lamps is at destination. The FAA, or agents of the FAA, shall at the sole discretion of the FAA, test and inspect all lamps received on a lot basis. Acceptance inspection will be done at the sole discretion of the FAA.

A lot is hereby defined as all lamps of one qualified design and source received at the same time and day and listed on one (1) transportation document by the carrier. These lots will be tested on a sampling basis in accordance with ANSI/ASQCZ1.4-1993. The Acceptable Quality Level, AQL, is 1.0 for all lamps defined by this specification.

The Inspection Level will begin with Level I. The inspection level will be adjusted according to the switching rules for the ANSI Z1.4 system defined by Figure 1 of Z1.4. Reduced inspection shall be Level S-4 and tightened inspection shall be Level II.

4.4.1 Waiver of Acceptance Testing

Inspection of finished products is an added cost. Contractors whose manufacturing process contains a documented and auditable multiple year record of manufacturing and delivering like products with an equal or lower rate of non-conformance ($AQL \leq 1.0$) may request a waiver in their proposal.

The FAA will audit the contractor's records. The audit may include witnessing the manufacturing process. When the FAA grants a waiver of acceptance testing, the contractor shall supply Certificates of Conformance. Each and every lot shipped to the FAA will include the Certificate for that lot. A duplicate Certificate will be mailed or electronically transmitted to the Quality and Reliability Officer (QRO) assigned to monitor the acquisition. The Contracting Officer issuing the formal documents for the acquisition will identify the QRO in the formal documents.

A responsible employee of the contractor shall sign all Certificates of Conformance. The contractor shall furnish a current list of authorized individuals to the FAA Contracting Officer. The certificates of conformance shall identify the number of lamps, identified by their date of manufacture and ordering designation, in each lot shipment.

4.4.2 Acceptance Tests

All lots will be visually inspected for transit damage. Inspection of the samples selected for acceptance testing will include; marking, packaging, concealed damage, physical dimensions and specified cleanliness of the lamp.

Acceptance testing will normally consist of: Photometric Tests, Wattage/Rating Test, and Short Term Overload Test. The FAA shall at its sole discretion, expand acceptance testing to include any other, or all, qualification tests.

4.4.3 Acceptance Inspection/Testing and Disqualification

The FAA will begin acceptance inspection at inspection Level I sampling rates and anticipates reducing the level of inspection to Level S-4. The Switching Rules for ANSI Z1.4, Figure 1, are modified as follows: If the Inspection Level is increased from Level I to Level II, the non-acceptance of 3 consecutive lots constitutes Disqualification of the lamp. All expenses for re-qualification of the lamp shall be borne by the contractor. An independent testing laboratory accepted by the cognizant FAA contracting officer shall re-qualify the lamp design.

4.4.4 Nonconforming or Rejected Lots

All lots found nonconforming by acceptance inspection and/or testing are the sole responsibility of the contractor, at the place of inspection or testing, when found nonconforming. The FAA, at its sole discretion, may elect to accept portions of nonconforming lots.

4.5 Test Methods

4.5.1 General

Testing of all lamps shall be as defined in this specification. Unless specified differently in a specific test, the following General Laboratory Test Method Guidelines, of section 5., of MIL-STD-810F, shall be followed: 5.1 Standard Ambient Test Conditions, 5.2 Tolerances for Test Conditions, 5.3.1 Suitability for environment., 5.3.2 Calibration., 5.4 Stabilizing Test Temperature, 5.4.1 Test item operating., 5.4.2 Test item non-operating., 5.8.1 Installing the test item in test facility., 5.8.2 Test item operation., 5.10 Information during Test., All of 5.11 Interrupted Tests including 5.11.1, 5.11.2, 5.11.3., 5.16 Water Purity., and 5.18.1 Monitoring test chamber parameters. All other requirements of aforementioned section 5 are specifically excluded.

The tests required by this specification are those that represent the operating environment for the specific lamp. Historically there has been an overemphasis of higher temperature operation. The inherent characteristics of tungsten-halogen lamps require elevated internal temperatures to achieve the halogen cycle.

The successful use of tungsten-halogen lamps in the colder geographic areas of FAA operation have historically created a standing order to maintain the lamps energized at

their lowest input power level. The low temperature test includes a Photometrics test to define the response of each offered design and validate the order to maintain continuous lamp power in cold conditions.

4.5.1.1 Physical Mounting

All testing of Type I lamps excepting Initial Conditioning (4.5.1.3), Wattage Rating (4.5.2.1), Low Pressure (4.5.2.4), and Life and Candela Maintenance (4.5.2.6) shall be performed with the lamp mounted in a VASI LAMP TEST SIMULATOR enclosure. The enclosure shall be supported to maintain a lamp horizontal position.

All other testing of Types I lamps shall be done in fixtures, jigs or holders appropriate to the specific test or sequence of tests.

4.5.1.2 Test Voltage and Current

Lamps furnished to conform to the requirements of this specification shall be tested for qualification and acceptance with sixty hertz (60Hz) alternating current power containing three percent (3%) total harmonic distortion, or less, of the fundamental (60Hz) frequency ($\leq 3\% \text{THDF}$). The life test, 4.5.2.6, shall be conducted with the power source defined in that specific test.

Copper wire, minimum American Wire Gauge (AWG) according to the following table shall be used from the terminals of the power supply to the connector to the lamp mogul prongs or screw terminal lugs.

Maximum Distance by wire length:	20 feet	30 feet	50 feet
Minimum Wire AWG:	#10 AWG	#8 AWG	#6 AWG

Application of maximum rated current for all six point six (6.6) ampere rated lamps shall apply power at four (4) amperes lamp current. After three (3) seconds the current shall be ramp increased to maximum rated current within three (3) seconds.

4.5.1.3 Initial Conditioning (Burn-in)

All lamps will be conditioned prior to testing. Conditioning will consist of maximum rated current operation for one percent (1%) of the rated life of the lamp design, i.e. a 2,000-hour rated life lamp would be operated at maximum rated current for twenty (20) hours. The lamp shall be operated with sixty-hertz (60Hz) alternating current and the current shall be controlled within a range of plus zero percent (+0%), minus one percent (-1%) of maximum rated current.

Lamps may be conditioned in a series circuit group. If conditioning is done in series, shorting devices shall be used to allow individual lamps to be removed for wattage

testing. Series loop current shall be reduced prior to the removal of any lamp to avoid over-current of the remaining energized lamps.

4.5.2 Specific Tests

4.5.2.1 Wattage Rating Test

The lamp shall be operated at maximum rated current for thirty (30) minutes prior to wattage measurement. All lamps shall be consistently and uniformly shielded from air movement other than the convection movement created by the lamp itself during this test.

Power supply voltage shall be set to produce maximum rated lamp current after these thirty (30) minutes and not changed during the lamp wattage measurement. The power supply voltage shall be regulated within one-tenth percent (1/10%) of setting.

Lamp actual wattage is defined as the average watts measured over a one (1) minute interval. Maximum and minimum watts shall also be recorded during this one-minute interval.

The average of all actual lamp wattages measured in each submitted sample shall establish the wattage rating for the submitted design. Reference 4.3, Qualification Testing.

Instrument accuracy shall be a plus or minus one-tenth of one percent ($\pm 0.1\%$) of reading, or better. The measured current and voltage values shall be continuously recorded or logged during the one (1) minute measurement interval.

Voltage shall be measured directly at the lamp mogul prongs or screw terminals, not at any type connector used to connect the power leads to the lamp.

4.5.2.2 Photometric Tests

Photometric tests shall be conducted at rated power to validate compliance with the intensity and beam dimension requirements of Table I. Each lamp shall be energized, set at full rated power, and operated at full power until it is as stable as demonstrated during the wattage rating test. The photometric measurements shall not begin until this stability is demonstrated.

After the beam dimension and intensity measurements at maximum rated current, without removing or disturbing the lamp, the Candela Output over Operating Power Range shall be measured, reference 3.4.4.1.

The input current for 6.6 ampere rated lamps shall be reduced to 5, 4 and 3 amperes respectively and the beam pattern and intensity measured at each input current value. The lamp shall remain in the test fixture for the overload and photometric test.

4.5.2.3 Overload and Photometric Test

The test chamber ambient air temperature shall remain as specified by the Photometrics Test. The lamp shall be operated for one hundred twenty (120) seconds at 110% maximum rated current immediately following the completion of the Photometrics Test.

The lamp input current shall then be reduced to rated and operated for thirty (30) minutes. A Wattage Rating measurement (one minute) shall be repeated immediately following this 30 minute equalizing period. Photometric measurements shall be made to define the results of the overload test.

Failure is defined as any one or more of the following:

- A. Destruction of the filament.
- B. Distortions of the filament resulting in a one degree (1°), or greater, change in the center axis of the beam in either the vertical or horizontal position.
- C. Change in beam pattern and/or beam intensity greater than two percent (2%).
- D. Wattage rating measurement differing more than one percent (1%) from previous measurement.

4.5.2.4 Low Pressure Test

The low pressure test shall be conducted in accordance with MIL-STD-810F, Method 500.4, Procedure II. The lamp shall be tested at atmospheric pressures corresponding to 10,000 feet (3,048 meters) altitude. Type I lamps shall be tested at -60°F (-51°C).

Lamps shall be tested for a total of six cycles of maximum rated current operation with a power off interval with the test chamber pressure and temperature maintained constant. A cycle is defined as operation for one (1) hour at maximum rated current, followed by one-half (1/2) hour off. Refer to section 4.5.1.2 for power application details.

Photometrics measurements shall be made to define any change in lamp output. The A, B, C and D requirements of the Overload Test also apply to the Low Pressure Test. All measurements needed for the B, C and D requirements testing shall be done immediately preceding this test using the same equipment and instruments used to perform the low pressure test. These measurements shall be made when the lamp output is stable at room temperature and ambient atmospheric pressure.

4.5.2.5 Low Temperature Test

The low temperature test shall be conducted in accordance with Procedure II, Method 502.4 of MIL-STD-810F. The temperature shall be constant. Type I lamps shall be tested at minus sixty degrees plus or minus two (2) degrees Fahrenheit ($-60^{\circ}\text{F} \pm 2^{\circ}\text{F}$) ($-51^{\circ}\text{C} \pm 1^{\circ}\text{C}$).

Test chamber test temperature shall be maintained for a period of six (6) hours prior to energizing the lamp. Temperature sensors shall be installed around the lamp in the test chamber. The test chamber temperature shall be maintained at -60°F .

The lamp shall be energized at maximum rated current, refer to section 4.5.1.2, Test Voltage and Current. A single point, center of beam, candela measurement shall be made with the lamp at room temperature and when the lamp is delivering stable output prior to the low temperature test. The same instrument used to measure candela shall be used at the same point of measurement during the low temperature testing.

A single point, center of beam, measurement of candela shall be made continuously from the time the lamp is energized until the candela has reached the value previously established. The time to reach this beam candela value shall be recorded.

If a specific lamp does not reach the specified candela value the test shall be ended when there is no longer an increase in candela of the specific lamp. In addition to the major and minor defects, failure of this test includes the lamp not functioning as a halogen cycle lamp at this low temperature.

It is understood the achievement of internal lamp capsule temperature necessary to initiate and maintain the halogen cycle is dependent on the retention of lamp heat.

4.5.2.6 Life and Candela Maintenance Test

The hours of maximum rated current operation of each lamp during previous testing shall be included in the total operating hours of each lamp for this test. Reference section 4.3, Qualification Testing.

Ambient air temperature for Type I lamps shall be fifty-four degrees Fahrenheit plus or minus five degrees Fahrenheit ($54^{\circ}\text{F} \pm 5^{\circ}\text{F}$) ($12^{\circ}\text{C} \pm 2.8^{\circ}\text{C}$). Ambient air temperature of the test chamber shall be maintained as specified for the duration of all life tests.

The life test shall be done with cycled or interrupted power supplied to the lamp by a FAA Type FA-10004 power supply or approved equivalent power supply. Reference 4.5.1.2, Test Voltage and Current. The lamp shall be operated for twelve (12) continuous hours at maximum rated current. Power shall then be turned off for a period of one (1) hour. Maximum rated current shall then be reapplied for twelve (12) more hours. This cycle of 12 hours on, 1 hour off, shall continue until all twenty (20) Type I lamps fail.

At the minus three sigma (-3σ) hours of rated power operation of the submitted design, the beam candela output shall not be less than ninety five percent (95%) of the initial candela established for the individual lamp by the Photometric Test. The life test shall include verification of the marking requirement durability of section 3.2.4.

The life test shall include a continuing measurement of individual lamp wattage determined by the filament voltage. Beginning at the offerer's stated -3σ hours of operation; individual lamp terminal voltage shall be measured and recorded. This voltage measurement shall be made, on every lamp, at the midpoint of every twelve (12) hour power on cycle of the life test. When the terminal voltage of any individual lamp, compared to the initial lamp terminal voltage established by the wattage test, confirms a change in lamp wattage exceeding one hundred fifteen percent (115%) of the initial value of the specific lamp, the useful rated life of the lamp is ended. Reference 4.3, Qualification Testing and 3.4.1 Wattage Rating.

The useful life of a lamp is also ended when the candela output of the lamp falls below eighty percent (80%) of the initial candela as defined by 4.5.2.2 Photometric Tests. The candela output of each lamp may be measured by single point center of the beam candela measurement or filament voltage. If filament voltage is used the testing laboratory shall verify the voltage determined to define the twenty percent (20%) drop in candela output is valid. This voltage value will be lamp design specific.

The testing laboratory shall perform a statistical analysis of the results of the life test for each submitted qualification sample. This analysis shall be based on a normal probability distribution for a new product using the guidelines and methods of Experimental Statistics, National Bureau of Standards Handbook 91.

5. PREPARATION FOR DELIVERY

5.1 General

Lamps shall be packaged for extended warehouse storage and reshipment. All packaging shall be in accordance with ASTM D 3951. Testing or validation shall be in accordance with ASTM D 4169, Assurance level II, and Distribution cycle 18.

5.2 Packaging

5.2.1 Preferred Packaging

Each lamp, with minimum one (1) inch cushioning, shall be packaged in an individual (unit package) fiberboard container. The long axis of the lamp filament shall be perpendicular to the bottom, and top, of the fiberboard container.

Unit packages shall be over packed in intermediate containers with six (6) unit packages per container.

Intermediate packaging and shipping containers shall be capable of multiple handling and storage under favorable conditions, such as enclosed facilities, for a minimum of one year.

5.2.2 Acceptable Alternative Packaging

Lamps may be packaged in containers with six (6) lamps per container. The container shall have a minimum of one (1) inch cushioning on all sides. All lamps shall be packed with the long axis of the filament perpendicular to the bottom, and top, of the container. The containers shall be capable of multiple handling and storage under favorable conditions, such as enclosed facilities, for a minimum of one year.

5.3 Palletized Shipments

All palletized shipments shall be made on disposable pallets whose maximum outside dimensions are forty-seven and one-half inches (47 ½") by forty inches (40"). Overall height of the pallet and contents shall not exceed forty-seven inches (47"). Fork entry of the pallet shall be on the long sides of the pallet. No portion of the load shall overhang or extend beyond any pallet edge. Shrink wrapping to secure intermediate containers is encouraged.

5.4 Marking

Unit and intermediate packages, shipping containers and palletized loads shall be marked in accordance with MIL-STD-129L.

The appropriate marking order is:

National stock Number (NSN)
CAGE Code and Part Number
Item description
Quantity and Unit of issue
Contract or Purchase Order Number
Level of Protection and Date Packed
Rated Life
Sigma Hours

6. NOTES

The contents of the subparagraphs below are only for information. They are not contract requirements, and are not binding on either the Government or the contractor except to the extent that they may be specified as such in other contract documents. Any reliance placed by the contractor on the information is wholly at the contractor's own risk.

6.1 Government Furnished Equipment

None.

6.2 Packaging Testing

It is recommended the contracting officer direct initial shipment of all qualification samples to themselves. When all qualification samples are received, one carrier, in one shipment, should transport all the samples to the independent testing laboratory. The receiving testing laboratory should inspect the packing and packaging as received for conformance and effectiveness.

6.3 Vibration Data, reference 3.4.8.5

This data will be used to help identify structures whose resonant frequency may well be the cause of shortened lamp life. The FAA does possess the necessary vibration analysis equipment and skills needed for this work. These VASI lighting systems are over flown by every known type of aircraft. Any frequency from a helicopter rotor to the inaudible frequencies from jet engines is possible. Structures usually respond harmonically to lower frequency.

Table I. Type I Lamp Requirements

The beam axis for all Type I lamps shall be within one-half degree ($\pm 1/2^\circ$) of the mechanical axis of the PAR64 bulb. Operating position for all Type I lamps shall be from horizontal to forty-five degrees (45°) base down. All type I APERTURE candela intensity measurements shall be made at a distance of one hundred (100) feet from the face of the APERTURE.

Ordering Designation: Q6.6A/PAR64/2P

Maximum rated amperes = 6.6

Nominal wattage rating in watts = 200

Color Temperature = 3000°K to 3200°K

Bulb = PAR64

Base = Mogul End Prong

Minimum candela intensity when measured in the VASI LAMP TEST SIMULATOR defined by FAA drawing C-5407-10 shall be 7,500 candela within the two inch by twenty seven inch (2" by 27") APERTURE shown on the FAA drawing.

Maximum candela intensity in the APERTURE shall not exceed 15,500 candela.

Ordering Designation: Q6.6A/PAR64/3P

Maximum rated amperes = 6.6

Nominal wattage in watts = 300

Color Temperature = 3000°K to 3200°K

Bulb = PAR64

Base = Mogul End Prong

Minimum candela intensity when measured in the VASI LAMP TEST SIMULATOR defined by FAA drawing C-5407-10 shall be 11,000 candela within the two inch by twenty seven inch (2" by 27") APERTURE shown on the FAA drawing.

Maximum candela intensity in the APERTURE shall not exceed 23,000 candela.

Table II. Qualification Tests

Required Tests In sequence	Type I Lamps 20 of 22	Type II Lamps	PAGE ref.
Wattage 4.5.2.1	Yes		18
Photometric 4.5.2.2	Yes		18
Overload and Photometric 4.5.2.3	Yes		19
Low Pressure 4.5.2.4	Yes		19
Low Temperature 4.5.2.5	Yes		20
Life and Candela Maintenance 4.5.2.6	Yes		20

Yes means the test is required for qualification of any design of this lamp type.